EVALUATE THE IMPACT OF PARTICLES SIZE DISTRIBUTION ON FRICTION FACTOR AND PRESSURE DROP FOR FLOW THROUGH PACKED BED

By

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DECLARATION

I do hereby solemnly declare that the above titled thesis submitted by me is partial fulfilment of the degree program enumerated above that:

1. This thesis is my original work, except where otherwise acknowledged in the text;
2. This work has not been published earlier; and
3. This thesis shall not be submitted further by me in future for obtaining any degree from this or another university/institution.

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ABSTRACT

This study has presented the flow of the water over packed bed which contains glass particles of spherical uniform shaped, 9.34, 13.30 and 23mm size and in the second phase of the study mix material of Marble, 5mm, Gravel 7.5mm, Acrylic ball 8.52mm and spherical glass size of 9.34 were mixed and used as a packing material. The flow of water was controlled using a regulator, initial and final pressure was recorded with pressure meter in packed beds. The findings of the study indicated that pressure drop increases using narrow size uniform shaped spherical glass particles while lower pressure drop has been seen with bigger size uniform shaped spherical glass particles. Moreover, in the case of mix material has higher pressure drop due to the irregular shape of the material and narrow size of the particles. The other variable of the study is friction factor, Reynolds Number and porosity of the material. The findings indicated higher Reynolds number is obtained for smaller particle size such as 9.34mm spherical glass shown higher Reynolds number compare to 13.30mm and 23.0 mm spherical bigger size particles. Additionally, the study concluded that the Reynolds number is not a linear function to friction factor. Lastly, higher porosity of the material is resulted higher pressure drop. In the recommendations, uniform shape, bigger size particles found more favourable to reduce pressure drop in packed beds.

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LIST OF ABBREVIATIONS

Abbreviation	Description
ΔP	Pressure drop through packed bed, Pa ($kg/m.s^2$).
L	The height of packing in the bed (m).
Dp	Spherical diameter
M	Dynamic viscosity of the fluid
ϵ	Void friction
Φ	Sphericity.
D	the particle size
A_p	Area of the particle
E	Porosity of the bed.
P	Density of fluid (kg/m^3).
ρp	Density of particle (kg/m^3).
ρb	Bulk density (g/cm^3).
ρt	True density (g/cm^3).
V	Superficial Velocity (m/s)
Q	the volumetric flow rate of fluid (m^3/see)
A	the packed bed cross sectional area (m^2)
V_0	Volumetric flow rate
fp	friction factor
R_e	Reynolds Number
dP	Diameter of the particle (m)
P	water density
ρw	density of water at laboratory temperature, (g/c m^3)
w_1	weight of the particles, (g)
w_2	weight of cylinder filled with water, (g)
w_3	weight of cylinder with water and particles, (g)
U	Fluid velocity
ρ	Fluid density

CHAPTER 1

INTRODUCTION

1.1 Introduction

A packed bed, in chemical processing, is a pipe, hollow tube, or any other vessel that is filled with a packing material. It might be randomly filled of small objects like Raschig rings otherwise it could be a precisely packing of a designed structure. Packed beds could also have adsorbents or catalyst particles like granular activated carbon, zeolite pellets, etc. Normally, the purpose of a packed bed is in order to improve contact between two phases in a chemical process or any other process. Packed beds can be used in a distillation process, a scrubber, or a chemical reactor, but packed beds were also used to store heat in chemical plants.

Generally, Newtonian fluid flow through packed bed obeys Darcy's law at low Reynolds number and packed bed is considered porous (Luckos & Bunt, 2011).The major application of packed bed has seen in chemical, metallurgical, nuclear and other process engineering industries. The utilization of packed bed in the industries is a catalytic reactor, drying, adsorption of a solute, wastewater treatment, gas absorption combustion, filter bed, and the crude oil flow in the reservoir of the petroleum (Zainab, 2010). A conventional packed bed is a tube of cylindrical shape which is filled with various shape and size packing materials. Figure 1.1 shows the commonly use packed bed tube;

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